CLAIMS

GENERAL

1. The method and apparatus offers a complete air-fluid distribution, control, and management system beginning with the primary mover of such a system and extending through to all components, branches, sub-branches, and terminal outlets/inlets required for air-fluid delivery of that system; the method of which comprises: fully articulated and intelligent flow sensor logic that determines total system losses versus total system gains, as well as terminal system losses versus terminal system gains, able to match appropriate movers to suitable distribution systems and vice versa in whatever form, number, or combination for multi-tasking purposes, including but not limited to leakage testing, system troubleshooting, design, and development; the apparatus of which comprises: a prime mover flow station fitted with TP (Total Pressure), SP (Static Pressure), and Vp (Velocity Pressure) sensors, a user interface, a panel display plotting mover and system operating points and fully illustrating all aspects of system or sub-system performance; the apparatus of which comprises: a terminal device, in-line device, or valve flow station fitted with TP, SP, and Vp sensors, a user interface, a panel display plotting mover and system operating points and fully illustrating all aspects of system or sub-system performance.

2. The key basis for operation of the method and apparatus is its fully articulated and comprehensive flow-pressure analysis, namely a breakdown of total power gained or lost in the form of Total Pressure, Static Pressure, and Velocity Pressure,

where in previous automated systems and design methods the velocity gradient was largely ignored and temperature-based systems more the focus.

3. The method and apparatus utilizes these three key pressure gradients noted in claim 2 to establish an exacting degree of influence that each carries throughout the system by determining a percentage of content of Total Pressure.

4. As a result of functions noted in claims 1, 2, and 3, the method and apparatus is able to diagnose specific problems and present solutions to those problems in an innovative and complete way as never before.

5. The described method and apparatus establishes a method and means of air-fluid flow control and testing that is far superior to existing systems, processes, and devices of flow control, flow metering, pressure gauging, or fluid delivery.

6. The method and apparatus provides the most complete, comprehensive, and articulated operation of HVAC, environmental, and air-fluid distribution systems.

7. The method and apparatus provides the highest level of precision currently possible in the evaluation of flow-pressure characteristics,

in many cases pointing out existing procedures' faulty and incorrect methods of same, even by known standards.

8. The method and apparatus encompasses an entire HVAC or air-fluid distribution system in full scope, from its primary mover to all terminal devices and components of an HVAC or air-fluid distribution system.

9. The method and apparatus offers in finest detail and broadest scope, a consummated system of air-fluid control and delivery.

10. The method and apparatus offers an innovative methodology and means of best exploiting thermal and fluid mechanic principles to their fullest extent possible

by all relevant HVAC and air-fluid control fundamentals,

withstanding or notwithstanding current improvements or failures in sensor technologies

11. The method and apparatus provides the most comprehensive and complete method of sensor logic control for HVAC and air-fluid distribution systems.

12. The method and apparatus will assist in design and implementation of most effective air-fluid distribution systems from the outset of any such project.

13. The method and apparatus establishes a consistent methodology with tools for utilizing such, from inception to "as-built" construction of an entire HVAC or air-fluid distribution system.

14. The method and apparatus establishes an appropriated methodology with tools for utilizing such,

from inception to as-built construction of an entire HVAC or air-fluid distribution system.

15. The method and apparatus establishes consistent application of all movers and components of an HVAC or air-fluid distribution system

16. The method and apparatus establishes a standardization of all movers and components of an HVAC or air-fluid distribution system.

17. The method and apparatus plots performance curves of movers and their systems,

terminal control devices and their systems,

or any air-fluid distribution component or proponent of flow-pressure application and its system.

18. The method and apparatus uses system and sub-system operating points.

19. The method and apparatus uses a breakdown of Total Pressure either gained or lost by movers and terminal devices, respectively, into Static Pressure, Velocity Pressure, and Total Pressure.

20. The method and apparatus uses three-part performance curves and corresponding operating points with those flow-pressure gradients noted in claim 2.

21. The method and apparatus plots exacting curves of all pertinent performance characteristics, including that of the primary mover, terminal flow control and heat exchange devices,

and considers all correlations between main sections, terminal branches, or any system component or proponent.

22. The method and apparatus correctly processes fluid mechanic and thermal dynamic relationships prior to effecting motor control over terminal flow control devices,

or any system components governed by flow-pressure relationships,

or heat transfer relationships.

23. The method and apparatus employs primary mover and terminal flow control device performance curves in a manner never before employed or properly implemented.

24. The method and apparatus employs the most useful aspects of fluid mechanics

as related to its own unique function or any function of flow and pressure sensing

in the context of any HVAC or air-fluid distribution system.

25. The method and apparatus measures every valuable sensory aspect of air-fluid and thermal flow

and makes calculated assessments as to its usefulness or uselessness for the specified purpose.

26. The method and apparatus maintains total and terminal control of an HVAC or air-fluid distribution system.

27. The method and apparatus presents an in-depth, comparative analysis of all components and proponents within an HVAC or air-fluid distribution system.

28. The method and apparatus serves lab use embodiments.

29. The method and apparatus serves field use embodiments.

30. The method and apparatus can greatly improve building management as it pertains to HVAC, air-fluid distribution,

and overall power consumption.

31. The method and apparatus can benefit energy management systems as they pertain to HVAC, environmental, or air-fluid distribution systems.

32. The method and apparatus utilizes novel sensor control functions to achieve precise air-fluid flow-pressure distribution and delivery characteristics.

33. The method and apparatus determines how best to process sensed flow-pressure readings

and thermal readings

for optimal efficiency, effectiveness,

and a multitude of useful purposes.

TP SP Vp GRADIENT INCLINATION - % OF FLOW-PRESSURE CONTENT

34. The method and apparatus features an innovative system of determining the percentage of content of a Total Pressure or a Total Power

and any other synonym or name assigned to this general idea never before used in this particular way or any other way

for determining specific usefulness as applied to said HVAC and air-fluid control systems and, generally, any systems involving described concepts.

35. The method and apparatus uses gradient inclination obtained from its breakdown of Total Pressure content into SP (Static Pressure) and Vp (Velocity Pressure)

through correct sensor interpretation to achieve its many functions.

% CONTENT

36. The method and apparatus establishes specific content: SP and Vp of TP (Static Pressure and Velocity Pressure of Total Pressure)

and presents this figure as:

a percentage of total content.

as a Vp factor: Vp/SP.

as an SP factor: SP/Vp.

in an HVAC system.

in an air-fluid distribution system.

in any system conveying a gas, fluid or other such mixture.

37. Referring to claims 34, 35, 36, the percentage of content is indexed on a user interface,

along with juxtaposed mover or system performance curves.

38. The method and apparatus may determine or, moreover, rule out, the "System Effect" factor imposed on a mover,

particularly due to its Vp gradient and inlet-outlet sensor logic in mover evaluation, and dynamic or other losses associated therewith.

39. The method and apparatus plots a compound curve of related flow-pressures comprised of TP, SP, Vp

and establishes percentages of content: SP/VP of TP

for each mover and any system component

so that exact, useful or useless damper/valve/terminal device, or mover characteristics may be plotted and evaluated

with a given starting point in the mover or system,

held constant or varied as desired.

40. The overall planned approach presented by the method and apparatus, which applies sensed flow-pressure gradients in the correct measure where and when needed,

will allow the conversion process of SP and Vp throughout a given system to preserve the utmost Total Pressure, this all the while decreasing in the direction of flow.

HEAT EXCHANGE

41. The method and apparatus correctly employs non-linear thermal dynamic measurements as obtained from moist air characteristics previously neglected in existing automated systems.

42. The method and apparatus employs thermal dynamic measurements and moist air characteristics for mutually advantageous heat flow and fluid flow.

43. The method and apparatus employs its thermal dynamic and fluid dynamic measurements to mutually benefit one another

and the air-fluid distribution system as a whole.

44. The method and apparatus may function as a humidifier/dehumidifier

by way of dry and wet bulb sensing functions,

by applying psychrometrics in determining RH (Relative Humidity,)

lbs/lb or grains/lb of moisture,

by controlling the percentage of OA (Outdoor Air) entering the system, through temperature and/or flow sensing as described.

by applying heat transfer to increase sensible (dry bulb) changes as required.

by applying heat transfer to increase enthalpy (wet bulb) changes as required.

45. The method and apparatus utilizes tandem heat transfer and flow-pressure cooperation.

46. The method and apparatus displays fluid changes, which may be viewed in tandem with load (heat flow) changes

to show how each is compromised or augmented

by any and all system changes.

47. Furthering claim 46, the method and apparatus allows for all HVAC or air-fluid system components to be viewed in tandem with one another,

along with all their performance characteristics,

in real or sampled time frames

48. Furthering claims 46-47, this display may be shown in any form, number or combination of components,

limited only by the size and scope of the entire distribution system.

49. The method and apparatus monitors heat transfer increases and decreases with velocity and pressure changes,
and temperature, density, specific gravity, specific heat changes

in forced convection cross-flow, parallel-flow, or counter-flow systems,

air to air, fluid to fluid, or air to fluid systems in the arrangements noted above

or in any form, number, or arrangement,

including gases and mixtures in any combination with above noted,

along with mass flow rate

and total enthalpy transferred, or latent and sensible changes individually.

50. Using the described method and apparatus, heat transfer may be precisely controlled at terminal heat exchangers

in tandem with temperature/density/specific gravity/specific heat changes of air and fluids for maximum effectiveness.

by maintaining maximum enthalpy differential possible within the given system or terminal device.

by maintaining the optimal mass flow rate possible within the given system or terminal device.

51. Between thermal and flow-pressure considerations, the sensing functions utilized by the method and apparatus will make maximum effectiveness possible,

namely to exploit the full potential of terminal heat exchange devices, under fixed or varying conditions.

EFFICIENCY AND EFFECTIVENESS

52. The method and apparatus can identify all adversities within a given system which contribute to inefficiency in whole and part

and determine specifically how these contribute to inefficiency in whole and part,

surmounting cause(s) of total inefficiency of said system(s) or sub-system(s) in its (their) entirety.

53. The method and apparatus performs a concise effectiveness evaluation of an HVAC or other such air-fluid distribution system in its entirety,

encompassing all known and described principles involved in its operation

to determine proper equipment sizing, capacity, and heat exchange effectiveness,

thereby affirming that all thermal and fluidic flow-pressure values are achieved in the most efficient way possible.

54. The method and apparatus juxtaposes a system's intended design characteristics against its actual operating characteristics under given conditions

and brings to light all factors contributing to total and individual causes of inefficiency or ineffectiveness.

TEMPERATURE CONTROL

55. The method and apparatus will be equipped with zone temperature or thermal sensors

to prioritize, localize, average, or omit any feedback from any particular zone, terminal device, or system component.

56. Proceeding from claim 55, the method and apparatus may avoid "crossover zones" and other undue external load influences.

and will not cause the system to misinterpret load changes by sensor feedback from those zones not served by the terminal branch.

57. Also, the sensing function of the method and apparatus may be oriented around areas that reflect the largest, smallest, or mean temperature demand, as selectively determined.

58. The method and apparatus may refer to building load calculations as provided by user input or referenced from its database of heat flow coefficients of construction materials, light fixtures, occupancy, and any and all sensible and latent influences.

59. With varying total and terminal demands in each project, the method and apparatus provides the means and tools to correctly match system thermal load and flow-pressure capacity to a given system

on a per project basis for the desired results,

totally and terminally,

thermally, statically, and dynamically.

MOVER TESTING

60. The method and apparatus may serve the function of a highly versatile and complete flow metering system

and pressure gauging system

for determination, diagnosis, and evaluation of any mover performance characteristics

across its full range of rotational speed,

and percentage of "wide open" flow,

within or without the context of an air-fluid distribution system.

61. The method and apparatus serves the function of assessing complete, flow-pressure gradient performance characteristics of a mover,

across its full range of rotational speed

and percentage of "wide open" flow,

within or without the context of an air-fluid distribution system.

62. Proceeding from claims 60, 61, the method and apparatus identifies every useful or useless quality of given mover

variably or fixedly,

to establish its own "wide open" flow characteristics

and/or those of a distribution system connected thereto.

and/or those of a terminal device connected thereto.

63. Proceeding from claims 60, 61 and 62, the method and apparatus determines the most suitable and effective operating range for a new or existing mover.

64. The method and apparatus will aid in the design and selection of the most appropriate mover for a given application

at a given Total Pressure applied by the mover

so the mover is not sized indiscriminately under or over that total capacity and power required for the given system to operate most efficiently and effectively.

65. The method and apparatus serves the function of assessing complete, gradient performance characteristics of a mover across its full range of closure,

with input/output flow–pressure being constant or variable,

with the ability to plot the most valuable or least valuable performance characteristics at any given input/output.

66. The method and apparatus can diagnose problems with an existing mover and/or system to which it is connected.

67. The method and apparatus will evaluate the performance characteristics of an existing mover and/or system to which it is connected.

68. The method and apparatus can determine how best to employ the mover's most valuable qualities,

and in lab use, assist in developing a more effective mover for future field use.

and in lab use, assist in developing an improved mover for future field use.

69. The method and apparatus serves the function of an intelligent and fully articulated mover flow-pressure control device.

70. The method and apparatus will operate within the framework of any new or existing system

notwithstanding any limitations of the actual mover to which it is fitted.

71. Regardless of the existing mover's limitations, the said method and apparatus will enable the most articulated control of that existing system

and best possible control of that existing system

until a novel mover succeeds current ones

and same principles as set forth by the method and apparatus will apply.

72. The method and apparatus will establish a comprehensive flow-pressure gradient evaluation of all mover performance characteristics,

their value or lack thereof,

in full scope of operation

within or without the context of a terminal device or system.

73. The method and apparatus will establish the best suited operating range

or point of greatest SP/Vp gain of the mover

under a given total pressure input/output, or throughput
with or without a "flow-through" or "draw-through" system connected.

TERMINAL DEVICE TESTING

74. The method and apparatus may serve the function of a highly versatile and complete flow metering system

and pressure gauging system

for determination, diagnosis, and evaluation of any air-fluid terminal device, valve, or damper performance characteristics

across its full range of motion,

within or without the context of an air-fluid distribution system.

75. Proceeding from claim 74, the method and apparatus identifies every useful or useless quality of given flow-pressure control device,

variably or fixedly,

to establish its own "wide open" flow characteristics

and/or those of a distribution system connected thereto.

76. The method and apparatus determines the most suitable and effective operating range for a new or existing terminal flow-pressure control device or valve.

77. The method and apparatus will aid in the design and selection of the most appropriate flow-pressure control device or valve for a given application

to operate within minimum to maximum parameters

at a given Total Pressure constant

so the flow control device or valve is not sized indiscriminately under or over that throughput required for the given system to operate most efficiently and effectively.

78. The method and apparatus serves the function of assessing complete, gradient performance characteristics of a valve or terminal device across its full range of closure,

with input/output flow–pressure being constant or variable,

with the ability to plot the most valuable or least valuable performance characteristics at any given input/output, or throughput.

79. The method and apparatus can diagnose problems with an existing terminal flow-pressure device and/or system to which it is connected.

80. The method and apparatus can evaluate the performance characteristics of an existing terminal flow-pressure device and/or system to which it is connected.

81. The method and apparatus can determine how best to employ the more valuable qualities of a terminal flow-pressure control device,

and in lab use, assist in developing a more effective device for future field use.

and in lab use, assist in developing an improved device for future field use.

82. The method and apparatus serves the function of an intelligent and fully articulated, total and terminal flow-pressure control device.

83. The method and apparatus will operate within the framework of any new or existing system

notwithstanding any limitations of the actual valve or terminal flow-pressure control device - in simplest form a motor-controlled damper with a defined range of motion - to which it is fitted.

84. Regardless of the existing terminal device's limitations, the said method and apparatus will enable the most articulated control of that existing system,

and best possible control of that existing system

until a novel terminal device, damper-actuator, or valve succeeds current ones

and same principles as set forth by the method and apparatus will apply.

85. The method and apparatus will establish a comprehensive flow-pressure gradient evaluation of all air-fluid valve or terminal device performance characteristics,

their value or lack thereof,

in full scope of operation

within or without the context of a system and/or sub-system.

86. The method and apparatus will establish the best suited operating range or point of greatest SP/Vp throughput for the valve or terminal device

under a given Total Pressure drop.

with or without a "blow-through" or "draw-through" system connected.

87. The very utilization of the described method and apparatus will directly result in the development of successive movers, terminal devices, and any and all air-fluid distribution system components.

88. The method and apparatus provides the most comprehensive and complete method of standardized procedure for testing HVAC and air-fluid distribution systems and their components.

89. The method and apparatus may serve the functions of claims 60 through 86 with or without a "blow-through" or "draw-through" system attached.

ESTABLISHING UNKNOWNS

90. Using the method and apparatus, an unknown mover with a known system attached may be evaluated.

91. Using the method and apparatus, an unknown system with a known mover attached may be evaluated.

92. Using the method and apparatus, an unknown terminal device with a known system attached may be evaluated.

93. Using the method and apparatus, an unknown system with a known terminal device attached may be evaluated.

94. Once mover characteristics alone are established, then the true operating point of an unknown system connected to that mover may also be established by way of the method and apparatus

and vice versa

95. Once terminal device characteristics alone are established, then the true operating point of an unknown system connected to that terminal device may also be established by way of the method and apparatus

and vice versa

MOVER OR TERMINAL SUITED TO SYSTEM AND VICE VERSA

96. The method and apparatus can aide in selection of compatible HVAC or air-fluid distribution movers and systems.

based on its comparative determination of compatible flow-pressure content characteristics as articulated through prescribed means and methodology,

along with any thermal or load considerations

97. The method and apparatus establishes the best method of and provides the best means of matching movers, terminal devices, and any and all HVAC or air-fluid distribution system components per application.

98. The method and apparatus may be used to determine which type of system is best suited to a mover for a given application.

99. Following from claim 98, the method and apparatus may be used to determine which type of sub-system is best suited to a valve or terminal device for the given application.
100. The method and apparatus may be employed to determine which type of air-fluid distribution system is best suited to a specific type of mover for the given application

by mating the given mover to its ideal system in every measurable respect,

using the gradient content sensing function of the method and apparatus

and described database functions noted in claims 156 through 167,

by matching the mover's full gradient performance characteristics,

moving beyond static efficiency as with traditional fan performance curves

extending the gradient breakdown to precisely match system characteristics

in maximum flow demand and minimum flow demand, or in any range or degree between,

allowing fan, system, and terminal component characteristics to be viewed entirely during the matching process,

allowing virtual or real "as-built" observation of such effects as changes are imposed on any particular component of the system.

101. The method and apparatus may be employed to determine which type of air-fluid distribution sub-system is best suited to a specific type of terminal device for the given application

by mating the given device to its ideal system in every measurable respect,

using the gradient content sensing function of the method and apparatus

and database functions noted in claims 156 through 167.

EQUIPMENT DESIGN, CATALOGUING, AND SELECTION

102. The method and apparatus uses Total Gains and Total Losses, along with Specific Gains and Specific Losses, comprised of TP, SP, and Vp,

to provide a complete evaluation of all system components,

whether in primary, secondary, tertiary, parallel, series operation, or in any other form, number, or combination of mover and system components.

103. System design is made possible with said method and apparatus,

firstly, in its determination of Total Gains versus Total Losses,

as they pertain to any primary, secondary, or tertiary movers and terminal devices arranged in series, parallel, or in any other form, number, or combination; by way of a critical path, a circuitous path, or any route as selected or determined.

104. System equipment selection will be made possible by said method and apparatus, firstly, in its determination of Total Gains versus Total Losses,

as they pertain to any primary, secondary, or tertiary movers and terminal devices arranged in series, parallel, or in any other form, number, or combination; by way of a critical path, a circuitous path, or any route as selected or determined.

105. Proceeding from claims 103-104, the method and apparatus will match the primary mover's Total Gains to a Total System Loss,

including any and all terminal, in-line devices, ductwork/piping/vessel/conduits, fittings, attachments, and all objects comprising that system through which the fluid must traverse to reach its critical run branch or any branch and return or be delivered, less any established diversity amount.

106. The method and apparatus will suitably match the terminal device's total throughput to its terminal branch sub-system, falling under total system considerations.

107. Proceeding from claims 105-106, the method and apparatus will then articulate Specific Gains and Specific Losses of all system components

and precisely assess individual needs of total system and terminal system requirements.

108. The method and apparatus enables the most precise selection of

or customization of

movers and terminal devices on a per project basis,

where neither current methods nor stock sizing support such precise application.

109. The method and apparatus provides the most comprehensive and complete method of standardized procedure for cataloguing HVAC and air-fluid distribution systems and their components.

110. The method and apparatus provides the most comprehensive and complete method of standardized procedure for designing HVAC and air-fluid distribution systems and their components.

111. The method and apparatus provides the most comprehensive and complete method of standardized procedure for selecting HVAC and air-fluid distribution systems and their components.

112. The method and apparatus may be employed to catalogue any mover, terminal device, or system component of a given air-fluid distribution system

and tabulate such data for useful reference purposes.

OPERATING MODES:

113. The method and apparatus employs various and versatile modes of operation.

114. The System Modes employed by the method and apparatus will establish what initial setup the primary mover and main damper control will have to activate for the desired mode of operation.

115. The operating modes of the method and apparatus will include, but not be limited to: Normal Mode Op, Smoke Mode Op, Balance mode Op, and Test Mode Op.

116. The method and apparatus will utilize MIN/MAX parameters as intended mainly for Balance Mode Op,

wherein these parameters may be calibrated in an unknown or "as-built" system for testing and balancing purposes.

117. The FULL OPEN/CLOSED parameters will be intended mainly for Smoke Mode Op, such as for purge systems or auto "shut down" systems.

118. The parameters set forth in claims 116-117 may also be used for any form or degree of "wide open" system testing, lab or field testing, or leakage testing, with or without a diversity, which may be done in Test Mode Op.

DEFAULT OP

119. The method and apparatus offers the key option of enabling Default Operation.

120. The option presented in claim 119 will produce the best results when the described method and apparatus is used from origination,

but may also function in an "as-built" system that has undergone comprehensive testing utilizing said method and apparatus

whereby its most valuable characteristics are determined and implemented

in so far as is possible, given the limitations of the existing system and components thereof.

121. Essentially, Default Op of the method and apparatus will place all components of the primary moving unit and system at settings that will be indexed according to its own pre-established criteria

or suggested operating ranges for movers and terminal devices

at given inputs, outputs, or throughputs.

122. In default operation, the method and apparatus may also adapt itself to the limitations of an unknown system to which it is connected

for peak efficiency

or any other purpose,

given the existing or "as-built" condition of the system.

123. The default mode of operation will also enable the method and apparatus to "learn" about how the many variables in the distribution system interact with one another.

to provide the best results, desired results, or most effective operation.

124. According to claims 90 through 95 and 119 through 123, the method and apparatus may function as an AI (Artificial Intelligence) system.

CRITICAL RUNS

125. The method and apparatus establishes a critical run or runs by way of total impact pressure sensing,

followed by a breakdown of flow-pressure gradients

for full-circle evaluation of system performance requirements as demanded from primary mover to critical run terminal and back, or otherwise freely delivered,

as has never before been utilized in an automated system.

126. The method and apparatus may determine TPR (Total Pressure Required) versus TPA (Total Pressure Available) at each terminal flow control device or valve inlet

as a given starting point to plotting all characteristics stemming there from,

with the option of obtaining test results with only TPA in whatever amount available

and adjusting damper/valve position when TPA exceeds TPR at a given set point

and may maintain damper/valve position at TPR set point

under changing system conditions

until TPA drops below this point.

SYSTEM DIVERSITY

127. The method and apparatus makes wider or larger diversities possible in HVAC or air-fluid distribution systems.

128. The method and apparatus may be employed to determine diversities in new or existing HVAC or air-fluid distribution systems.

129. The method and apparatus may be employed to identify diversities in new or existing HVAC or air-fluid distribution systems.

130. When a system diversity is present, the method and apparatus may be used to

expand or widen the margin of the diversity and

determine which paths of distribution can best be utilized in dispersing range and run of this diversity.

131. The method and apparatus serves the added function of Mapping System Diversity,

a selection which allows an air-fluid distribution system to be analyzed in whole and part

under set conditions to map the most appropriate terminal runs for inclusion in the margin for diversity, namely those that are the *least critical.*

132. The method and apparatus performs the function in claims 127 through 131 by described sensing noted in claims 125-126 at each terminal device and value comparisons drawn after establishing the *most critical* run at any designated section of the system.

133. The method and apparatus can evaluate Terminal Branch system curves and their operating points on a per branch basis,

in whatever scope or section of the Total System is desired,

as the gradient breakdown of these sub-systems may be either complementary or rudimentary to the terminal device.

134. Following from claim 133, the method and apparatus can evaluate the Total System curve and its operating point,

covering all Terminal Branches and system components,

as the gradient breakdown of the Total System may be either complementary or rudimentary to the primary mover.

135. Proceeding from the function noted in claim 133, the method and apparatus may determine the specific losses of the "least critical" and "most critical" runs

for further comparative evaluation as to their suitability for inclusion in the diversity

under any given conditions, as variable or fixed.

VECTORIAL - OP

136. The method and apparatus displays a vectorial depiction of all mover and system changes
which may be viewed superimposed on the actual main curve displays,

or viewed separately as changes occur in real or sampled time periods.

137. Using the function noted in claim 136, the method and apparatus provides a "bare bones" rendition of any changes that occur within the system, totally and terminally.

138. Furthering claims 136, 137, the method and apparatus uses vector graphics to indicate directional movement of the total and terminal system operating points

signifying changes in TP, SP, Vp, BHP, mover speed of rotation, voltage, amperage, or any other parallel drawn from these key indicators,

or any and all components, proponents, or opponents of the system

as represented by any distinct movement of the OP compass cross-hairs.

139. Furthering claims 136 through 138, the vectorial may also be superimposed on a psychrometric chart display of the method and apparatus to animate heat flow movement,

including moist air characteristics, latent changes (vertical movements,) sensible changes (horizontal movements,) and adiabatic changes (diagonal movements.)

140. Furthering claim 139, the heat flow changes may be viewed in tandem with those functions noted in claims 136 through 138.

141. The method and apparatus uses vectors to portray mover and system changes

as may be imposed arbitrarily

or under any mode of operation

142. Through vectorial interpretation, the method and apparatus may compare and contrast individual components of the HVAC or air-fluid distribution system in whole or part.

143. Using known equipment data as referenced from its own database or other sources, the method and apparatus may function as a virtual system for HVAC or air-fluid distribution system performance.

144. According to claim 143, the total and terminal effects of an entire air-fluid distribution system may be viewed prior to any system being built.

145. According to claims 143-144, the method and apparatus can emulate established performance characteristics into real time virtual performance.

146. Any OP generated by the method and apparatus may be user manipulated.

147. The function of claim 146 enables a user to manipulate the OP in horizontal, vertical, or in any movement between,

the purpose of which may be to create desired effects in the mover and system

or terminal device and sub-system under total considerations

with or without compromising one or the other elements at work in the whole system,

such as, but not limited to, BHP, heat transfer, or flow-pressure relationships,

while still maintaining necessary constants.

148. Noting claim 147, a fixed OP generated by the method and apparatus may be the desired constant in a variable system undergoing many changes.

POSSIBILITIES DISPLAY INTERFACE

149. The method and apparatus can troubleshoot hardware equipment failures that would prevent itself from proceeding through each sequence of its own operation.

150. Using its unique methodology and sensor logic, the method and apparatus may determine where in a distribution system a specific problem originates from,

namely whether it is internal or external to the primary mover, terminal device, or any and all system components employing such method and fitted with such apparatus.

151. The method and apparatus will identify problems occurring internally to the mover housing

by way of its static pressure profile

and gradient flow-pressure breakdown,

noting any discrepancies therein

as compared to previous knowns

as compared to an intended point of operation

from inlet to outlet of packaged movers and terminal devices.

152. The method and apparatus may also determine the nature of the problems presented in claims 150-151 by way of its gradient inclination (TP, SP, Vp)

and any discrepancies these may indicate within any mover, terminal device, component, or compartment of the HVAC or air-fluid distribution system.

153. The method and apparatus can intelligibly diagnose and correctly interpret specific causes of air-fluid distribution problems

in exacting degree,

such as leakage, undue flow, undue restriction, or adverse mover performance as outlined in claims 189-201,

within a given known or unknown context,

with knowns established as outlined in claims 90 through 95

and with system curve deviations from known system operating points or those designated,

as they have never before been intelligibly diagnosed or correctly interpreted by an automated system or any other system.

154. The method and apparatus troubleshoots by way of a Possibilities Display on its user interface, which draws from an expandable database.

155. The features of claims 149 through 154 and all database information with which the method and apparatus is equipped offers a preventative measure against any oversights, omissions, or other such problems attributed to human error, which may be overlooked by the user of said method and apparatus.

DATABASE

156. The sequence of operation will adhere to, but will not be restricted by the procedure of the method and apparatus as outlined in its description,

though any omissions due to unknown or previously non-established effects will be duly accounted for by way of an upgradeable database.

157. The feature of the method and apparatus noted in claim 156 will include any and all pertinent data, such as late mover equipment (blowers, pumps, motors, drives, etc.) and late system components (ductwork, piping, vessels, conduits, terminal devices, valves, etc.)

158. The expandable databases will include any and all scientific and engineering data pertaining to thermal and fluid mechanics,

such as psychrometric data tabulated in tenths of degrees or lower,

such as tabulated heat transfer coefficients for various construction materials

such as overall coefficients of heat transfer or thermal transmittance,

duct/piping friction loss/head loss tables, fitting loss coefficients,

any K or Ak factors, correction factors, Reynolds numbers

as pre-determined by accepted methods

or as established with said method and apparatus.

159. The expandable databases will include any and all scientific and engineering data pertaining to any air, gas, fluid, mixture, or element properties, including but not limited to:

composition of matter,

a periodic chart of the elements,

any known properties as pre-determined by accepted methods

or as established with said method and apparatus.

160. The method and apparatus will refer to its database, as noted in claims 156 through 159, in the course of system design and selection, though ultimately this is a user decision.

161. The method and apparatus will draw system and sub-system data from database storage

of ductwork/piping/vessel friction/head loss data,

of fitting loss coefficients,

of heat transfer coefficients,

of any HVAC or air-fluid distribution system component

to be stored and retrieved from a timely source.

162. The method and apparatus will draw mover data from database storage

of known mover performance characteristics as established with said method and apparatus,

of known mover characteristics as established by the gradient breakdown of Total Pressure and curve plotting by way of said method and apparatus,

of known mover characteristics as established by other accepted means,

of known mover types, sizes, and capacities.

163. The method and apparatus will draw terminal device data from database storage

of known terminal device performance characteristics as established with said method and apparatus,

of known terminal device characteristics as established by the gradient breakdown of Total Pressure and curve plotting by way of said method and apparatus,

of known terminal device characteristics as established by other accepted means,

of known terminal device types, sizes, and ranges.

164. All equipment sizing and capacity may be entered manually from tabulated data or other reference materials as a featured option of the method and apparatus and, thus, user or default options will allow flexibility in this area.

165. Ultimately, the method and apparatus can carry over all mover and system component data from any stage, from equipment cataloguing, design and selection, to field testing,

whether fully automated or otherwise prepared from tabulated references and calculation.
166. The described database will also contain all this standardized information for immediate reference and curve plotting,

particularly if created and stored on the same system

or retrieved from a computer file.

167. The method and apparatus may reference known system ductwork, piping, or any system component

to obtain exact fitting, area, and length of run dimensions,

to determine exactly how these pertain to the monitored flow-pressure characteristics

by sensed flow-pressure value comparisons to database reference

by comparison of standard or corrected air-fluid velocities per equivalent diameters or cross sections of duct/piping/conduit

by comparison of known fitting loss coefficients or equivalent pipe length associated with fittings.

FINAL COLLATION

168. The method and apparatus will present a final deduction of all system characteristics

to be reduced to total power (or wattage) consumed by the system in whole,

specific power (voltage and amperage) consumed by the system in whole,

along with the power produced and used by the primary mover,

actual power factor and efficiency of its motor,

and overall performance factor (input to output.)

169. Totally and terminally, the method and apparatus breaks down final energy assessments into BHP, kilowatt input/output, and BTUH or MBH heat flow.

170. Following the actions of claims 168-169, a further breakdown of the system's individual components will be analyzed,

including specific heat content in BTU/lb, a static measurement,

all total and individual gains and losses, thermal or fluidic,

and effectiveness of heat exchangers.

171. The method and apparatus can draw parallels between flow-pressure and electrical flow (amperage-voltage,)

with each system component having its own characteristic effect on localized and general power draw.

172. Through more detailed analysis, the method and apparatus can identify how various conversions of Total Pressure throughout the system play on the Total System power draw

under varying loads, demands, and differing conditions as arbitrarily set.

173. Through database reference, the method and apparatus can evaluate the sizing and fitting of all main and terminal branch runs

as provided from shop drawings or computer-designed dimensional data stored as retrievable files

with any late revisions reflecting true "as-built" conditions

to be suited to or contrasted against known or pre-established performance curves

and operating points based on intended design configuration

or "as-built" configuration.

174. In its final analysis of an "as-built" system, the method and apparatus may determine whether designated performance is at all possible

with the given system's fitting or retro-fitting,

or as specified on commissioning of a project.

175. If the method and apparatus determines that the designated performance is not possible, as noted in claim 174, it can make exacting recommendations for required equipment sizing, capacity, and selection, beginning with primary mover's Total Pressure required and extending to all main and sub-branches of the system and their respective terminal flow control devices.

176. Proceeding from claim 175, the method and apparatus may suggest what specific action: installation, retrofit, test, adjustment, or balance must be performed to correct this problem.

MOTOR-DRIVE

177. The method and apparatus can automatically recommend pulley and drive sizes as well as motor sizes

by direct BHP and drive pulley calculation

as derived from motor-drive reference data or user input,

and actual sensed performance characteristics,
namely driven rpm, voltage, amperage, and total flow capacity under given testing conditions

with static pressure being the least regarded verification point in a field test.

178. The method and apparatus may also recommend "tag" HP or any late motor-drive equipment that may be obtained from catalogued stock sizing, as would readily be available from its database.

179. By preserving utmost Total Pressure and, thus, power, the method and apparatus will create lower horsepower demand and lower the total power required to perform specific tasks at any given time.

STOCK SIZING

180. The method and apparatus can provide all equipment performance and selection data, from primary mover and terminal device sizing, down to final motor-drive adjustment

through its own internal database,

through other catalogued sources,

through user entered data.

181. Overall use of the method and apparatus stands to improve the precision of HVAC or air-fluid distribution equipment sizing, selection, and design

if said method and apparatus is used from origination,

whether or not method and apparatus is used from origination

EMBODIMENTS:

SERIES AND PARALLEL OP - GENERAL

182. Movers, terminal devices, and all system components may work in conjunction with one another in various arrangements under the method and apparatus, such as but not limited to the following:

two or more damper or valve controls in series or parallel,

with auxiliary fan power (secondary movers) arranged in series or parallel,

any primary, secondary, tertiary, etc., movers arranged in series or parallel,

induction terminals, with or without mover power, arranged in series or parallel,

in all forms such variable air volume or constant volume terminal devices are extant,

in three-way mixing or diverting type valves, terminal devices,

movers or system components placed in opposition or diversion,

any applied or resulting flow-pressure placed in opposition or diversion,

all of the above in any given number or combination

DUAL DAMPER OP

183. Parallel Damper Operation of the method and apparatus, as demonstrated in FIG. 16A, may be used for a system with excessive bends and fittings (Vp gradients.)

184. Including the function in claim 183, Parallel Operation of the method and apparatus may also serve a function in Constant Pressure applications (where volume is variable),

with mover application, speed control, terminal devices, and all related system components working in conjunction.

185. Series Damper Operation of the method and apparatus, as demonstrated in FIG. 16, may be used in those systems with longer runs and minimal fittings (SP gradients.)

186. Including the function in claim 185, Series Damper Operation of the method and apparatus may also serve a function in Constant Volume applications (where pressure is variable),

with mover application, speed control, terminal devices, and all related system components working in conjunction.

187. Under the Parallel Damper Operation of the method and apparatus, the Secondary parallel damper and additional flow source provide a cumulative velocity to traverse fitting and directional losses.

188. Adding to the function in claim 187, the Primary damper may provide critical run leverage by generating Static Pressure

in conjunction with forced mover application and motor-drive speed control,

thus maintaining adequate Total Pressure.

LEAKAGE TESTER – SYSTEM LOSSES AND GAINS

189. The method and apparatus can accurately distinguish between types of losses or gains within an HVAC or air-fluid distribution system.

190. Referring to claim 189, the method and apparatus can determine whether losses or gains within a given system - or relative, specific deviations from a given system operating point - can be attributed to leakage, undue flow, or undue restriction.

191. The method and apparatus can also determine whether such losses or gains as noted in claims 189-190 result from an adverse system condition, whether such losses or gains result from adverse mover performance, and whether such losses or gains result from adverse terminal device performance.

192. The method and apparatus serves the added function of a leakage tester

for a capped duct main section or some unknown vessel or enclosure,

for a new or existing system that has already been fitted.

193. Proceeding from claim 192, precise leakage test results may be obtained through use of the method and apparatus with or without a known system and operating point.

194. The leakage tester embodiment of the method and apparatus allows for convenient in-line leakage testing

at any point in a distribution system under control of same method and apparatus,

from the primary mover to any designated section

where there is a terminal device fitted with damper control throughout a system in entirety,

and/or where there is controlled mover application

by way of speed control or other means,
whereas previously, crude orifice plates and cumbersome "clamp-on" leakage testers have been employed with enormous effort and inconvenience, one capped section at a time.

195. The method and apparatus may determine leakage rate and quantity

or undue flow and quantity

by variances in the system curve plotted against any mover or terminal device and its respective system or sub-system

that reflect relative increases in Velocity Pressure and, conversely, decreases in Static Pressure.

196. The method and apparatus may determine undue restriction and quantity

by variances in the system curve plotted against any mover or terminal device and its respective system or sub-system

that reflect relative increases in Static Pressure and, conversely, decreases in Velocity Pressure

197. The method and apparatus may use terminal device damper shut-off to bring the system section to its Static Pressure rating and maintain this level.

198. Proceeding from claim 197, the method and apparatus is then able to measure quantitative velocity passing through the system, per duct surface area, as a direct indication of leakage,

its exact flow-volume or CFM amount,

and whether it is within acceptable tolerances.

199. The sequence of leakage tester operation of the method and apparatus may proceed as follows:

The mover ramps up or the terminal device closes its damper-actuator until static sensor input reaches the entered value of the duct rating and stops.

Once SP and Vp solitary curves experience level off, the exact percentage of Vp content is determined and noted in sampled or real time flow-pressure readings.

SP and Vp solitary curves are displayed, plotting level-off plateaus, where each gradient is required to remain constant under testing conditions.

This figure is then converted to FPM units across the adjusted area,

this determined from only that section being isolated for testing.

CFM leakage flow rate is established.

200. The method and apparatus may be used to conduct official leakage testing

with a control damper or mover application used to bring system Static Pressure level up to the ductwork, piping, or other vessel rating and isolating its Velocity Gradient,

by employing plotted system or sub-system curves with actual operating points, noting specific deviations from those intended,

201. As an alternative to claims 192 through 200, the method and apparatus may simply perform leakage testing under normal operation by determining the leakage factor at any given time through specific Vp gradient deviations from known OP's that cannot be attributed to undue flow,

under any given conditions or modes of operation,

throughout any rotational speed and capacity of mover performance,

throughout the full parameters of a terminal device or damper/valve range of motion.

VOLUME OF A GIVEN VESSEL OR ENCLOSURE

202. The said method and apparatus may determine the interior volume of a given vessel or enclosure

by metering a free flow rate prior to encountering pressure

and considering density of air or specific gravity of a fluid entering a vessel.

203. The system curve of the vessel/enclosure may be established through precise, instant flow readings using described method and sensing apparatus

with or without a known terminal device connected thereto,

with or without using the method and apparatus from origination in determining mover and terminal device characteristics.

204. Proceeding from claim 203, the method and apparatus monitors the free flow rate until build up of static resistance causes it to begin to cease.

This exact point, wherein flow encounters maximum resistance - or total *static* power of the primary mover - will be marked as a cutoff point.
The exact flow-volume rate that passed the metering device will be derived from CFM units, after Vp is converted to FPM.

205. The method and apparatus will plot and notate any flow-pressure characteristics beyond this pivotal point, noted in claim 204.

206. Extending claim 205, the method and apparatus will continue to monitor any static and dynamic factors present after the vessel has been filled to its full interior volume,

or more indicatively, when the primary mover has reached its total static power, *less* the total static drop of the metering device, *less* any Vp which may exist in the form of leakage leaving the vessel at a steady rate.

207. Thus, proceeding from claim 206, a lesser, "tapering off" of dynamic flow may be measured, displayed, and interpreted by the method and apparatus as a leakage rate after the threshold of full volume has been reached.

208. Following the function in claim 207, the method and apparatus may note Static Pressure qualities as well, before and after the vessel has reached its full volume,

considering whether compressible or non-compressible air/gas/fluid/mixtures are being used

or whether compression is being administered by mover application

and what changes of air/gas/fluid/mixture state may be occurring.

209. The functions of the method and apparatus noted in claims 202 through 208 may be displayed as solitary curves, independent of any system.

210. The method and apparatus embodiment of claims 202 through 209 may also be used for compressible air, gases, fluids, or mixtures, given temperature/density/specific gravity/specific heat corrections.

211. The method and apparatus may set the desired level of compression

by monitoring and adjusting these figures and functions noted in claims 202 through 210,

along with adjustment of temperature/density/specific gravity/specific heat,

along with Static Pressure, which may be expressed in PSI, Hg, or in any other convenient unit of such pressure gauging.

212. After full volume of the vessel is achieved one time over, the process of claims 202 through 211 may continue until the desired state, specific heat, temperature, density, or specific gravity of the air, gas, fluid, or mixture is reached.

213. The air/gas/fluid/mixtures may be further compressed beyond the point of initial volume achieved in claims 202 through 212, with temperatures, densities, specific gravities, and specific heats being precisely monitored and set by the method and apparatus according to known properties of the given air/gas/fluid/mixture or level of compression possible within the given vessel.

214. The air/gas/fluid/mixture properties noted in claims 210 through 213 may be referenced from the database held by the method and apparatus,

which may include such timely data as required to determine air/gas/fluid/mixture properties

and a periodic chart of the elements extending to mixtures thereof.

215. The embodiment described in claims 202 through 214 may be suited to the same or other air-fluid distribution system for its refrigerant compression/expansion cycle,

affording precise control of the mover (compressor) and thermostatic expansion valve, or any terminal device used to gauge, meter, and adjust refrigerant flow.

216. Flow-pressure control by means of the method and apparatus within the vessel containing the gas in changing states can be beneficial to the refrigeration cycle,

with properly timed movement or flow-rate throughout its distribution cycle and changing states.

217. The method and apparatus provides the means to control such a system noted in claims 215-216 with quantitative precision and exact timing crucial to the compression and expansion cycle,

as this tends to over or under shoot in current systems with wide dead bands, not allowing full heat exchange to take place between the evaporative and condensate phases.

218. Employing the method and apparatus in such a manner as described in claims 215-217 avoids loss of and boosts optimal heat exchange effectiveness within the evaporative cooling system itself,

which may simply be viewed as a distribution system with terminal control and a mover (compressor) of one form or another.

219. Through processes described in claims 202 through 214, the method and apparatus may be used to determine ACH (Air Changes per Hour,) ACM (Air Changes per Minute,)

or any other unitary measurement of air-fluid changes occurring within a vessel, compartment, or enclosure

by applying the desired time frame to each complete change of volume constituting one standard change or any corrected change.

OTHER USES

220. Using the method and apparatus, terminal device throw patterns or isovels may be precisely formed with specific flow-pressure content

for terminal diffusers, infusers, or other flow device outputs/inputs.

221. The pressure-sensing component of the method and apparatus can determine distance of delivery (or travel) and rate of flow (or speed)

in exacting degree with prescribed gradients,

into an open space or within some contained vessel or enclosure.

222. Utilizing the method and apparatus, throw patterns can be more precisely applied and formed in exacting detail with both thermal and fluid mechanics considerations.

223. From the usage described in claim 222, zone sensing, along with flow-pressure sensing of the method and apparatus may be applied to control the effect of the given room, vessel, compartment, or any other enclosure.

224. The throw pattern formation described in claims 220-223 may be viewed with thermal or infrared viewing to observe its actual appearance and specific content, thermally and mechanically.

225. Such an observation as described in claims 220-224 may serve a purpose with other fluids, such as gases or air-gas mixtures with or without combustion and/or thrust being produced for specific and useful work.

226. Noting claims 220-225, the term and concept "terminal diffuser" may be likened to a thrust nozzle, a fuel injector, or any terminal device of air-fluid-gas-mixture delivery

with all previously described benefits of Total pressure and specific content delivery.

227. The method and apparatus may measure performance parameters in four dimensions, including time frame.

228. In diffusing considerations, the method and apparatus may provide the total "push" to move the air-fluid an adequate distance, then the speedy exit for its final delivery

into an open zone,

into another vessel or conduit of air-fluid delivery.

229. According to claims 220 through 228, throw patterns can be precisely applied with adjustable qualities consisting of force, distance, spread or radius of diffusion, and rate of delivery or terminal velocity.

230. Additional factors that may be used in the above functions noted in claims 220-229 are angle of exit, type and size of the terminal diffuser or infuser,

ambient condition of the free space or contained vessel into which air-fluid is entering,

secondary air-fluid mixing,

any coanda or thermal effect the above may contribute together with air-fluid delivery provided by the method and apparatus in shaping the isovel.

231. The method and apparatus enables controlled mixing of primary and secondary room air-fluid, induced air-fluid, air-fluid within a vessel, or any type of air-fluid stream in any form, number, or combination, including those noted in claim 182.

232. According to claims 220 through 231, sweep patterns of air-fluid delivery may be achieved by use of the method and apparatus.

233. According to claim 232, exact particulate control may be achieved by use of the method and apparatus.

234. The method and apparatus may be used to establish total building pressurization and maintain individual room or compartment pressurization within a building envelope,

such that a differential static pressure is measured from room to adjacent room/area/zone,

such that a velocity pressure is measured from room to adjacent room/area/zone,

such that a total pressure is measured from room to adjacent room/area/zone,

such that all rooms within a building are relatively lower in pressure to a given core area up to the outer bounds of the building envelope and out to open atmosphere.

235. Using the method and apparatus and the knowledge that precise force can be applied where 10" WC equates to 5.2 lbs/ft Sq. of force over area, this function may serve a room pressurization application, such as that used for medical or clean rooms.

236. The functions described in claims 234 and 235 may be used most effectively under constant or varying conditions to meet preset parameters for desired building pressurization on a per room basis with a consideration of all rooms and changes incurred, such as opening doors or any other total pressure loss or gain due to internal or external factors.

237. Following from claims 235 and 236, the room pressurization and differential functions may be applied in terms of static differential between rooms, normally set at +-0.05" WC or in any other unitary terms of measurement for clean rooms or smoke compartments.

238. Citing claims 190-201 and claims 234-237, the method and apparatus may be used to determine overall leakage of a building envelope, or any enclosure or vessel,

establishing any infiltration or exfiltration occurring,

and may determine the exact nature of these effects; their full impact, thermally and mechanically.

239. Building smoke control and related systems stand to benefit from the method and apparatus

by way of its Smoke Mode Operation,

also due to high pressure and high volume considerations required for such systems,

particularly where such a function requires precise application of high and low flow-pressure considerations

to generate pressure layers or "sandwiches,"

to otherwise provide any form of egress from a building under alarm,

by way of high flow-volume evacuation of smoke, or high-pressure purging of columns, corridors, elevator shafts, compartments, or other such vessel or enclosure.

240. The method and apparatus offers an invaluable tool for educational purposes related to HVAC, mechanical engineering, scientific measurement, and general air-fluid distribution systems as described in their design, use, or implementation.

241. The described invention is an indispensable equipment designing, selecting, testing and troubleshooting method and apparatus for HVAC or air-fluid distribution systems and all of their components.

242. The method and apparatus may function as an Ak or K factor determiner

for any terminal or in-line device,

terminal system branch,

or system whole.

243. The method and apparatus may function as a general flow coefficient determiner

for any HVAC or air-fluid distribution system and its components.

244. The method and apparatus uses "Upstream Leverage" as an added proponent in air-fluid distribution and control.

245. The proponent in claim 244 further contributes to maximum preservation of Total Pressure throughout the distribution system,

as well as maximum preservation of any flow-pressure gradient individually throughout a system,

and specifically distributes each flow-pressure gradient (Vp/SP) as needed,

where and when needed within a system

per Specific Losses and Specific Gains.

246. The function of the method and apparatus noted in claims 215-218 may similarly apply to any cooling or heating system condensate, expansion, absorption, or other cycle, with or without a change of state, involving air-fluid mechanics, including gases, mixtures, and thermal measurements as described in any form, number, or combination.

FLOW-HEAD (OR FLOW-PRESSURE) STABILITY

247. The method and apparatus increases and improves the characteristics of the critical range of valve movement between full flow to full bypass.

248. The method and apparatus maintains optimum flow-head stability in variable volume hydronics or like systems with three-way differential bypass control on the primary circuit and two-way control on the secondary or any terminal circuit,

with or without a variable speed mover.

249. The method and apparatus maintains optimum flow-pressure stability in variable volume air or like systems with two-way control on the secondary or any terminal circuits, with either variable speed mover, vortex vane, or bypass relief control to maintain system pressure.

250. The method and apparatus maintains optimum flow-head (or flow-pressure) stability in any constant volume system with three-way valve control.

251. Proceeding from claims 247 through 250, the method and apparatus maintains optimum flow-head (or flow-pressure) stability in constant volume and variable volume systems in any form, number, or combination.

252. Proceeding from claims 247 through 251, the method and apparatus maximizes the movers ability to absorb distribution system short-circuiting

and maintain maximum flow-head (or flow-pressure) rates at end terminals or critical runs.

RANGE OF MOVER-SYSTEM LOADING AND UNLOADING

253. The method and apparatus can establish appropriate boundaries for pumping or moving equipment operation that represent parameters of possible loads.

254. This designated operating region as noted in claim 253 outlines the scope of pumping or moving energy that can be conserved when mover speed is variable.

255. The method and apparatus greatly increases and expands this area of operation noted in claims 253 and 254, namely due to its ability to expand the system diversity and improve performance characteristics as noted previously in claims 127 through 135

and its individual breakdown of TP into Vp and SP where and when needed,

and as specifically demanded by terminal or in-line components with all of their pre-determined characteristics therewith, the latter as previously established with same method and apparatus or otherwise.

256. Through maintaining optimal flow-head stability and previously described use of the method and apparatus, the method and apparatus minimizes the valve pressure ratio increase between the mover and valves or terminal/in-line devices within a distribution system.

257. According to claims 253-256, the method and apparatus makes possible a wider range of load and, thus, a flatter operating curve for terminal equipment.

258. According to claims 253-257, the method and apparatus can also permit the use of steeper curved movers to maximize their limited range within distribution systems,

or vice versa; steeper curved systems may be paired with flatter movers.

259. It then follows from the above claims 253-256 and previous description that the method and apparatus allows automatic control valves and all variables within a given distribution system or sub-system to operate in a greater, more effective range.

260. The method and apparatus can plot independent system curves or independent heads to illustrate and define system constants against any system variation as produced by loading/unloading within the system, as thermally or mechanically caused.

261. Resulting from claim 260, the pressure (head) or flow capacity may be arbitrarily adjusted to either increase system pressure or increase system flow and place the operating point where desired, noting in particular that the relationship need not be inversely related, wherein one decreases as the other increases,

as these may also be viewed and controlled as independent variables, related or unrelated, and manipulated for useful purposes by way of the method and apparatus.

262. Following from claims 260 and 261, the use of the method and apparatus allows one to alter the system characteristics independently, and/or alter the mover characteristics independently,

ultimately reconfiguring the system operating point or juxtaposing the new operating point with a previous one.

263. The described method and apparatus can enable a given distribution system to attain maximum heat exchange effectiveness

by its preservation of Total Pressure or Total mass flow rate throughout any and all heat exchange devices

through any medium in any state

with a calculable content of Vp or SP where and when needed.

264. In variable air systems, the method and apparatus can plot a total differential pressure constant and the related boundaries for system performance, based on total external - Total, Static, and Velocity pressures to and from a critical run or any run, under constantly changing conditions; changes to the system curve, changes to the mover, and subsequent changes to the operating point.

265. In variable hydronics systems, the method and apparatus can plot a total differential head constant and the related boundaries for system performance, based on total head differential to and from a critical run or any run, with or without a consideration of Velocity Pressure, under constantly changing conditions; changes to the system curve, changes to the mover, and subsequent changes to the operating point.

USER FRIENDLY

266. Despite its sophisticated operation, the method and apparatus maintains accessibility and ease of use to an average user,

namely through its mode of Default Operation and general automation of any and all problem solving,

and simple Ak/K factor adjustment to a given total or sub-system.

267. Proceeding from claim 247, the user may subsequently learn the more intricate functions of the method and apparatus

through constant use,

through trial and error,

by observation of operating point deviations, noted causes of such,

by noting any adverse or beneficial effects of changes through arbitrary adjustment.

FINAL CONCLUSIONS

268. The prevailing differences between the described method and apparatus and current systems lie in temperature control with direct digital motor control alone versus complete, fluid-mechanical control; thermally, statically, dynamically, and totally.

269. Beginning with the primary mover and extending to every region of a system, the described method and apparatus's many innovative functions may govern any and all HVAC or air-fluid distribution systems in whole or part.

270. The method and apparatus is a complete, stand alone system with no previous platform derived from current automated systems or claiming benefit from any current systems, but rather only greatly contributing to and offering advantage to any existing systems or current means of air-fluid distribution and control.

271. Between Total Power and Total Pressure breakdown, there will be no unknown that cannot be deduced or induced by the method and apparatus under actual operation of a real system and, prior to this, the projection of design operation will be most accurate if the method and apparatus is used from origination, consequently making any extrapolation of performance characteristics more viable from the outset.